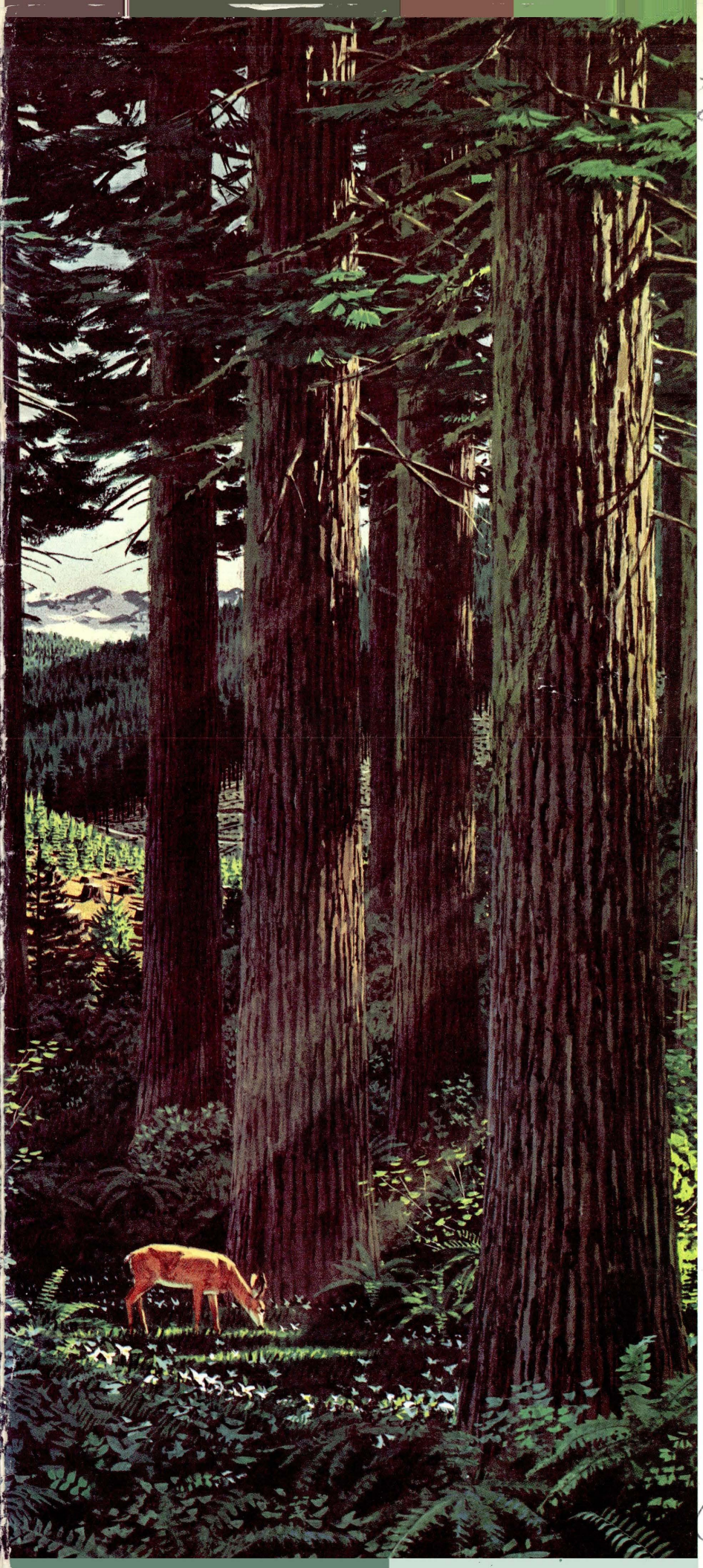

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Weyerhaeuser Forestry Paper

No. 13 – August 1968

The Balsam Woolly Aphid on Young Pacific Silver Fir in Washington

by

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and
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Forestry Research Center
Centralia, Wash.

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ABSTRACT

Johnson, Norman E. and John G. Zingg. 1968. The balsam woolly aphid on young Pacific silver fir in Washington. Weyerhaeuser Forestry Paper No. 13. Weyerhaeuser Co., Centralia, WA 98531. 10 p.

Young Pacific silver fir (Abies amabilis (Dougl.) Forbes) trees, in addition to older timber, are now being severely attacked by balsam woolly aphids (Adelges piceae Ratz.). Height growth may be almost halted within 10 years of infestation. Extreme caution is advised in planting susceptible tree species.

THE BALSAM WOOLLY APHID ON YOUNG PACIFIC SILVER FIR IN WASHINGTON

Norman E. Johnson[1]

and

John G. Zingg[2]

The balsam woolly aphid (Adelges piceae Ratz.) continues to spread through the true fir forests of the western United States. It is now common at several locations in Oregon, and especially so in the Mount Rainier Province of Washington (Franklin, 1965). Pacific silver fir (Abies amabilis (Dougl.) Forbes) is the host tree most frequently selected, but until recently mortality was believed largely restricted to older timber (Johnson and Wright, 1957; Johnson, Mitchell and Wright, 1963). Now however, it is evident that young trees also are being seriously affected.

The purpose of this paper is to discuss this new class of damage, and examine its likely significance. Most of our work was carried out in the Mount Rainier Province at locations near Kosmos, Vail, and Mount St. Helens.

STAND CHARACTERISTICS

The young trees studied were formerly understory components in mature forests of Pacific silver fir and western hemlock (Tsuga heterophylla (Raf.) Sarg.) in mixture with occasional Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) and western redcedar (Thuja plicata Donn.). At that time, few were more than 5 feet in height. Then after removal of the older timber some 12-17 years ago these smaller trees showed a spectacular surge of growth (Table 1). At the same time some other trees developed directly from seed.

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At each location, young Pacific silver fir is now growing with species that reflect the character of the original overstory. At Kosmos and Vail western hemlock and Douglas-fir are the most frequent species, with western redcedar and Pacific silver fir occurring in mixture. At Mount St. Helens, Pacific silver fir is the principal species although Douglas-fir, western hemlock and western redcedar are also present.

STUDY METHODS

Five heavily infested trees and five non-infested trees of corresponding diameters were felled at each location in August, 1966. Data collected include total height, height growth for each of the last 10 years, diameter at breast height, total age, and effective age--that is, the age since release. Also, two discs were cut from each tree--one at breast height and the other at mid-crown--and taken into the laboratory where moisture contents and specific gravities were computed. Moisture content was expressed as a percentage of oven-dry weight, and specific gravity as oven-dry weight per unit of water-soaked volume. Diameter growth for each of the past 10 years was measured on the oven-dried sections.

RESULTS

The released trees grew at similar rates in the period immediately after logging which indicates they were not previously infested by aphids. But after 7-9 years some trees did begin to suffer heavy aphid attack and this resulted in almost complete curtailment of height growth (Fig. 1). The data from each area were combined since all showed nearly identical trends.

When data from the discs were analyzed statistically, we found a significantly higher moisture content in the wood of uninfested trees, and a higher wood density in the infested examples (Table 2). There was, however, no difference in the weight per unit volume of green wood. The bark made up slightly more than 13 percent of the green weight of the samples.

Diameter growth of infested trees both at breast height and mid-crown was initially slightly greater than for uninfested trees (Fig. 2). In eastern Canada, Balch (1952) noted a similar increase in diameter growth on moderately infested balsam fir (Abies balsamea (L.) Mill.).

TABLE 1. Characteristics of 15 aphid-infested, and 15 uninfested Pacific silver fir trees.

Description	Trees	D.b.h.		Total height	
		Range	Average	Range	Average
	(number)	(inches)	(inches)	(feet)	(feet)
Kosmos					
Uninfested	5	3.8-5.0	4.5	18.5-24.7	21.0
Infested	5	3.9-6.5	4.4	10.2-21.5	14.0
Vail					
Uninfested	5	3.8-6.6	5.4	21.0-34.2	26.4
Infested	5	4.1-8.9	6.6	16.6-27.9	20.9
Mount St. Helens					
Uninfested	5	4.5-6.3	5.6	22.7-26.0	24.5
Infested	5	4.7-6.5	5.8	12.9-17.7	15.3
All					
Uninfested	15	3.8-6.6	5.2	18.5-34.2	24.0
Infested	15	3.9-8.9	5.6	10.2-27.9	16.7

	Actual age		Effective age[1]	
	Range	Average	Range	Average
	(years)	(years)	(years)	(years)
Kosmos				
Uninfested	14-49	35	10-14	12
Infested	12-88	39	12-14	14
Vail				
Uninfested	15-48	24	11-14	13
Infested	17-50	34	10-19	15
Mount St. Helens				
Uninfested	15-59	34	14-15	14
Infested	16-60	35	13-16	15
All				
Uninfested	14-59	31	10-15	13
Infested	12-88	36	10-19	15

[1] Effective age is the age since release.

TABLE 2. Characteristics of wood samples from each of 15 aphid-infested and 15 uninfested Pacific silver fir trees.

Description	Samples		Specific gravity	
	Discs	Trees	Range	Average
	(number)	(number)	(gms/cc)	(gms/cc)
Kosmos				
Uninfested	10	5	0.385-0.504	0.428
Infested	10	5	0.470-0.574	0.518
Vail				
Uninfested	10	5	0.330-0.420	0.371
Infested	10	5	0.343-0.523	0.417
Mount St. Helens				
Uninfested	10	5	0.355-0.488	0.396
Infested	10	5	0.413-0.582	0.475
All				
Uninfested	30	15	0.330-0.504	0.398
Infested	30	15	0.343-0.582	0.470

	Green weight		Moisture content	
	Range	Average	Range	Average
	(gms/cc)	(gms/cc)	(%)	(%)
Kosmos				
Uninfested	0.96-1.10	1.05	118-170	146.1
Infested	0.95-1.09	1.03	83-119	100.3
Vail				
Uninfested	0.98-1.06	1.03	142-201	176.9
Infested	0.86-1.03	0.99	81-191	137.5
Mount St. Helens				
Uninfested	1.00-1.08	1.04	122-193	163.9
Infested	0.99-1.08	1.04	75-147	121.2
All				
Uninfested	0.96-1.10	1.04	118-201	162.3
Infested	0.86-1.09	1.02	75-191	119.6

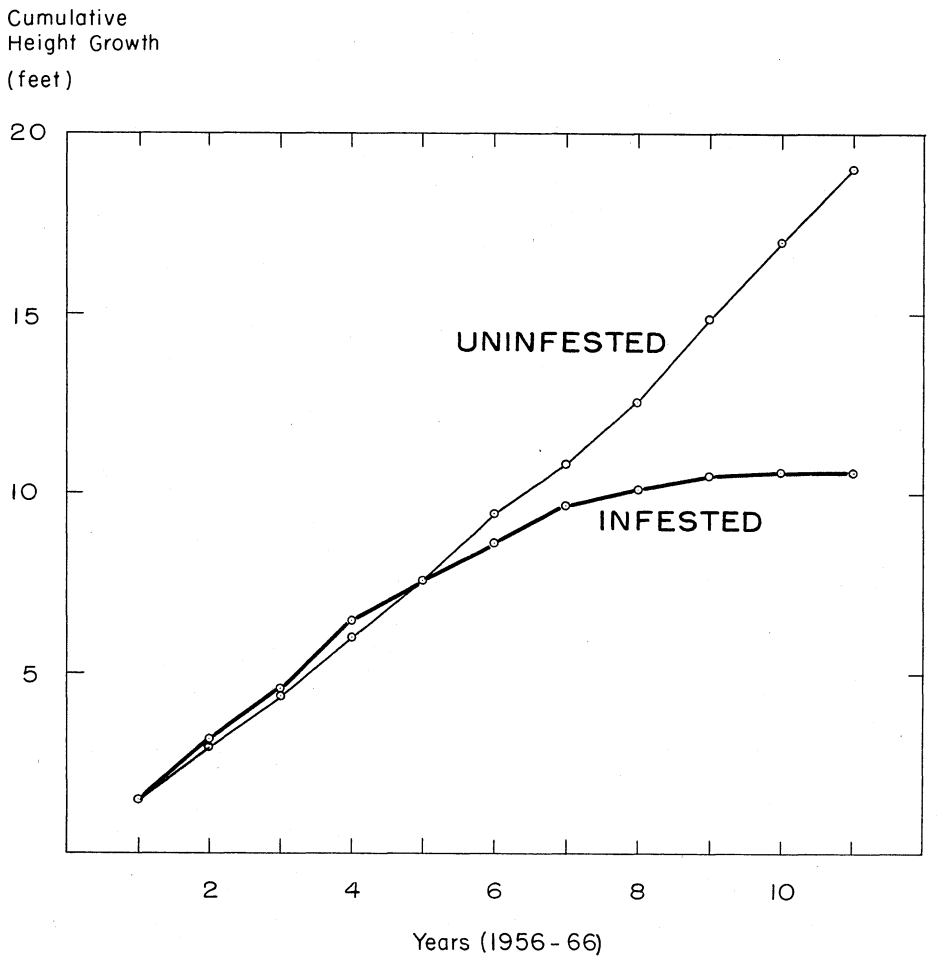

FIGURE 1. Comparison between height growth of infested and uninfested Pacific silver fir trees. Attack by the balsam woolly aphid markedly curtails height increment.

In our own study, the outermost growth ring of the heavily infested trees was noticeably narrower than the others (Fig. 5). Since the trends were similar on each area the data were combined.

In appearance, the growth rings of an infested tree are characteristically irregular and their location may be obscured by the presence of numerous false rings (Fig. 5). Dark areas are also present (known as "rotholz," or redwood) which have many of the properties of compression wood (Doerksen and Mitchell, 1965). This is the feature that accounts for the increased density of infested stems. A study by Foulger (1968) shows that wood of grand fir (Abies grandis (Dougl.) Lindl.) formed during aphid infestation is different from wood formed under more normal circumstances. Tracheids are shorter, fibril angle is greater, growth rings are wider, and there is a greater percentage of

late wood. Also, specific gravity is greater, the modulus of elasticity is reduced, longitudinal shrinkage is greater, and there is a higher than normal lignin content. None of these characteristics is particularly desirable in wood intended for pulp or lumber production.

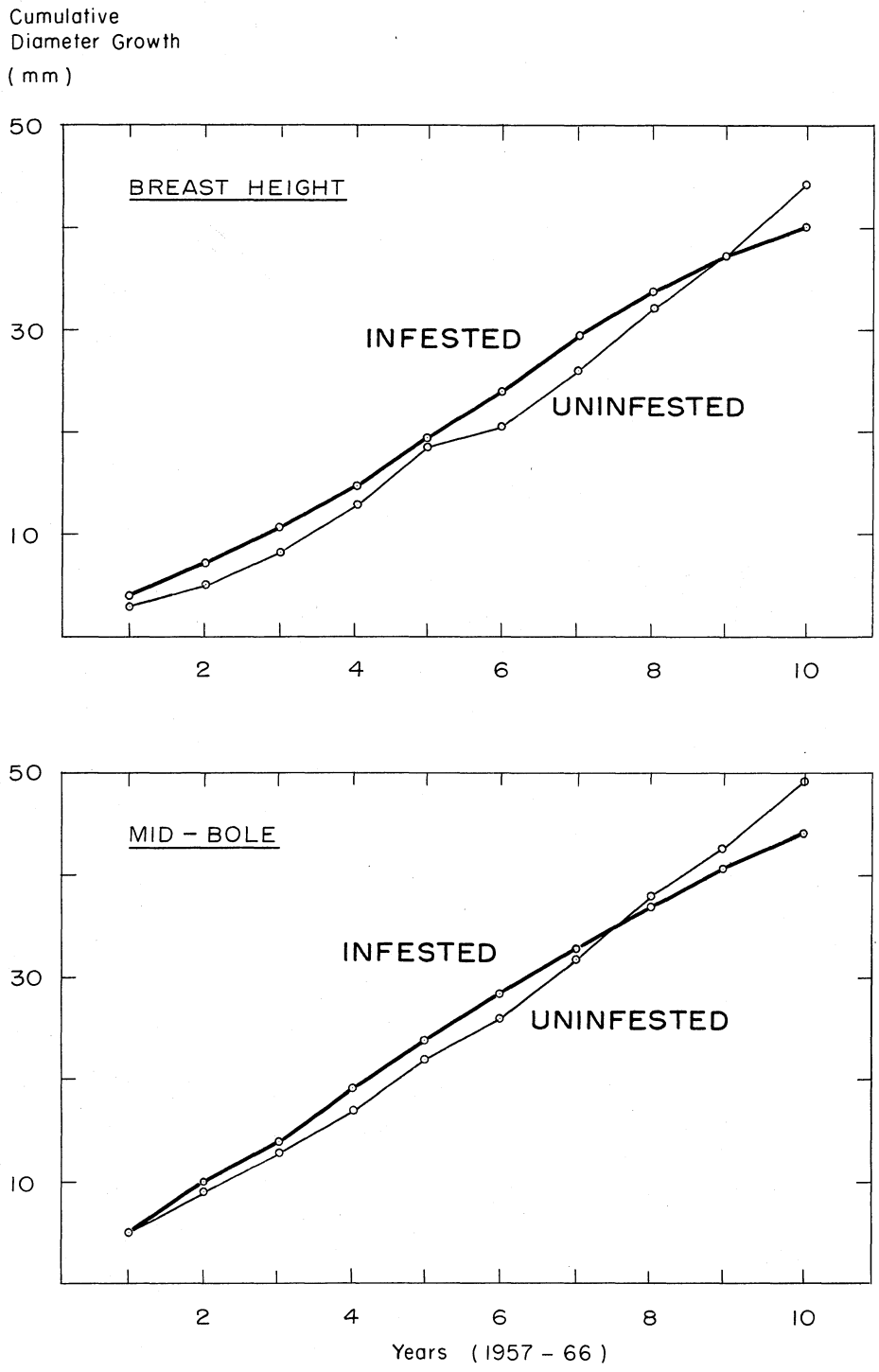

FIGURE 2. Comparison between diameter growth of infested and uninfested Pacific silver fir trees. Attack by the aphid apparently causes an initial increase in growth, followed by a decrease.

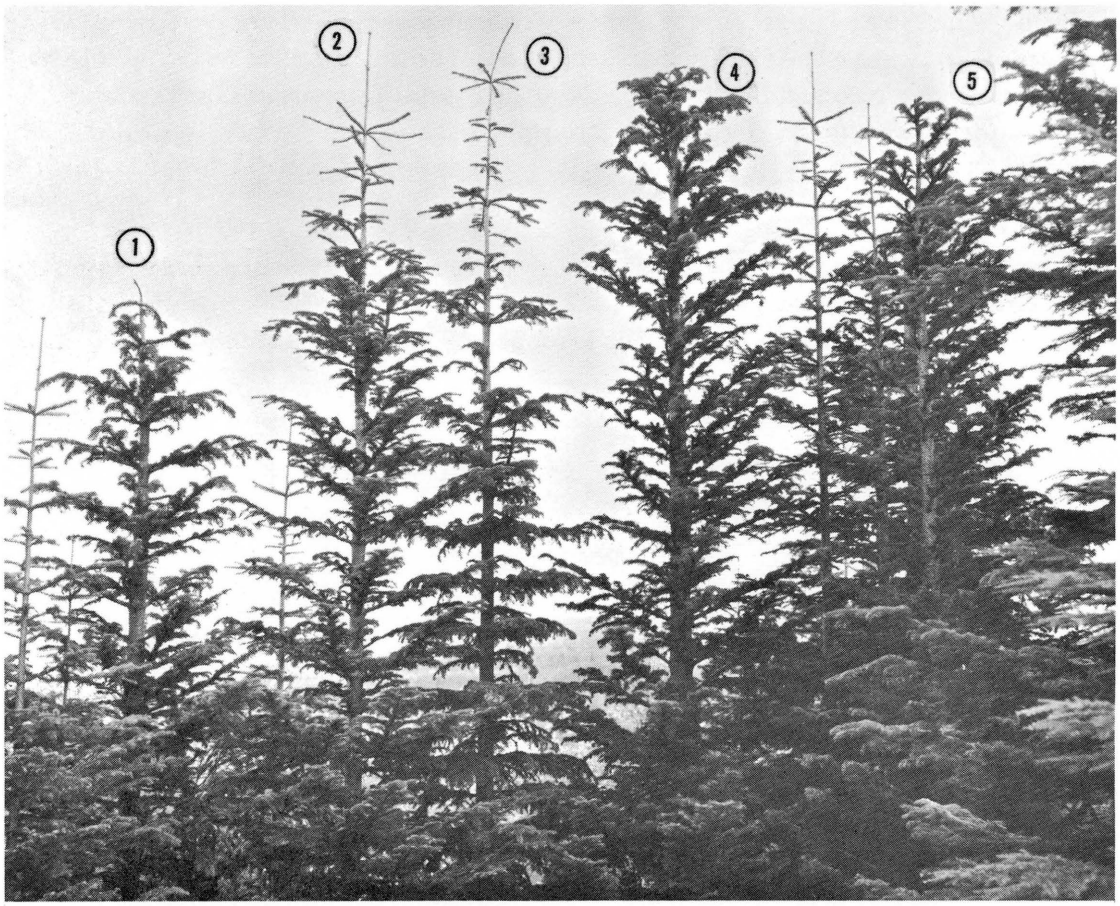

FIGURE 3. The severity of damage caused by balsam woolly aphid attacks can vary greatly, even among closely adjacent trees. Trees 1, 4, and 5 already are severely malformed, while the inclined leader of 3 marks the onset of growth curtailment. Number 2 is barely affected although supporting aphids on its lower branches.

DISCUSSION

Pacific silver fir is one of the most tolerant western conifers (Baker, 1949), and is therefore capable of growing in its own shade and continuously perpetuating itself. Before logging, all of the stands in the study areas had an understory of Pacific silver fir and western hemlock growing beneath them. Some of these understory trees were seedlings; others, although only a few feet in height, may have been 100 years old. After removal of the overstory they responded quickly and became dominant members of the new stand (Aho, 1960; Hanzlik, 1932). The question then, in the face of ensuing aphid attacks here and elsewhere, is "What should be done with these areas?"

When the trees prone to aphid attack are in mixture with resistant species, their loss may not seriously reduce per acre wood yields. If they die, or growth is impaired, other species will take their place in the canopy. But when (as often happens) the trees grow in local concentrations their death will result in a significant potential volume loss.

Since the intensity of aphid attacks varies greatly from area to area, and tree to tree (Johnson et al. 1963; Mitchell, 1966) there may be some locations where the success of young Pacific silver fir is not in

FIGURE 4. Even small trees sometimes support heavy stem attacks. Trees such as this produce millions of aphids which can spread to other trees in the area.

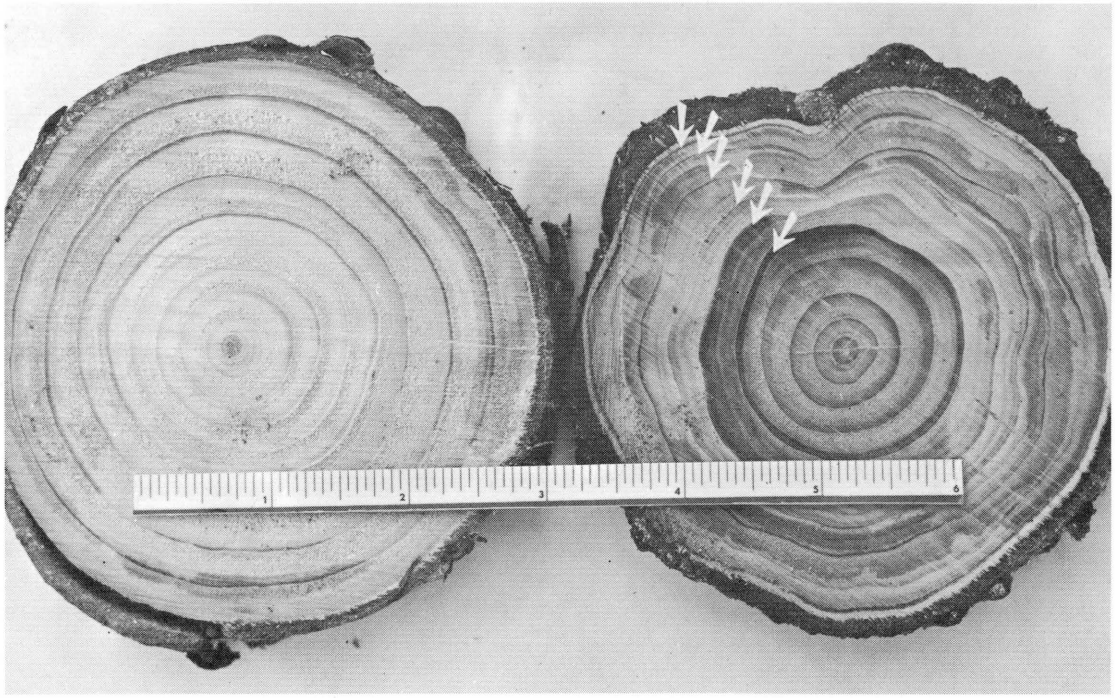

FIGURE 5. Cross sections from two Pacific silver fir trees, one barely attacked by aphids (left), the other heavily infested for 6 years. Irregular growth rings (arrows), numerous false rings, and darker, more dense wood are characteristic of severely attacked trees.

question. On the other hand, and as we have shown, the debilitating effects of the insect on young trees can be serious. It behooves the forest entomologist to recognize where the aphid is likely to be a problem so that the forest manager may use his recommendations to plan the future of stands in those areas.

Based on observations to date, we anticipate the greatest aphid threat to be in Pacific silver fir stands at the lower limits of the tree's elevational range, and on better sites along valley bottoms and benches. Usually Douglas-fir and western hemlock can be substituted for Pacific silver fir in these locations provided the site is properly prepared. Burning following logging may well be the best way to achieve this preparation. Without this, the forester should be wary of planting Pacific silver fir in areas now infested or believed likely to become so.

To date we have not found the aphid on young noble fir (A. procera Rehd.) and so at higher elevations this still appears to be a reasonable substitute for Pacific silver fir. Conversely, attacks on young grand fir are widespread (Heikkenen, 1966; Mitchell, 1966). The range of this species approaches that for Pacific silver fir at lower elevations in the Mount Rainier, Willamette and Coast Range Provinces, and the species should not, therefore, be considered a substitute.

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